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In the matter of an application for a German Patent in the name of Merck Patent GmbH, filed under No. 100 38 858.2 on 4 August 2000, and in the matter of an application for a United States Patent.

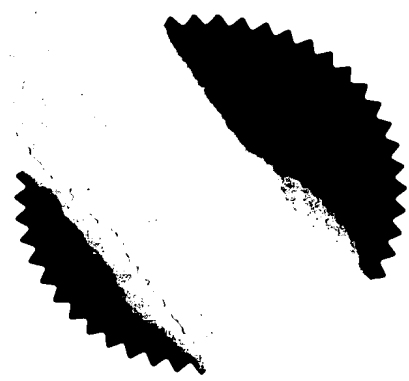
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Dated this 25th day of July 2003



Dr. Ashwood Stephen Drane



FEDERAL REPUBLIC OF GERMANY



Priority certificate regarding the filing of a patent application

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Date of filing: 4 August 2000

Applicant/proprietor: Merck Patent GmbH, Darmstadt/DE

Title: Fluoroalkyl phosphates for use in electrochemical cells

IPC: C 07 F, H 01 M, H 01 G

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mit beschränkter Haftung
64271 Darmstadt**

**Fluoroalkyl phosphates for use in
electrochemical cells**

Fluoroalkyl phosphates for use in electrochemical cells

The present invention relates to fluoroalkyl phosphates, to a process for their preparation, and to their use as conductive salts in batteries, capacitors, supercapacitors and galvanic cells.

The spread of portable electronic equipment, such as, for example, laptop and palmtop computers, mobile telephones or video cameras, and thus also the demand for lightweight and high-performance batteries, has increased dramatically worldwide in recent years.

In view of this suddenly increased demand for batteries and the associated ecological problems, the development of rechargeable batteries with a long service life is of constantly increasing importance.

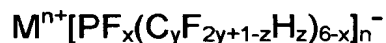
Lithium ion batteries and double layer capacitors with very high capacities (so-called super- or ultracapacitors) represent the current state of the art. In both systems, hydrolysis-sensitive and thermally unstable substances in the form of LiPF_6 or $\text{N}(\text{C}_2\text{H}_5)_4\text{BF}_4$ are currently used as conductive salt. In contact with moist air or with residual water from the solvents, HF can form rapidly. Besides the toxic properties, HF has a very adverse effect on the cycle behaviour and thus on the performance of the electrochemical cells.

Alternatives which have been presented are imides, such as bis(trifluoromethylsulfonyl)imide or bis(pentafluoroethylsulfonyl)imide, or methanides, such as tris(trifluoromethylsulfonyl)methanide and derivatives thereof. These salts exhibit high positive-electrode stability and, with organic aprotic solvents, form solutions of high conductivity. However, the imides have the disadvantage that they do not sufficiently passivate the aluminium metal which functions as negative-electrode current collector in batteries. By contrast, methanides can only be prepared and purified at very great effort (Turowsky, Seppelt, Inorg. Chem., 1988, 2135). In addition, the electrochemical properties, such as oxidation stability and passivation of aluminium, are very highly dependent on the purity of the methanide.

The object of the invention was therefore to provide conductive salts which are electrochemically stable and are simple to prepare. A further

object of the invention was also to extend or improve the service life and performance of batteries, capacitors, supercapacitors and galvanic cells.

Surprisingly, this object is achieved by the provision of fluoroalkyl phosphates of the general formula (I)



(I)

in which

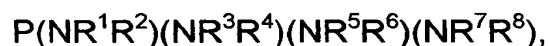
$$1 \leq x \leq 6$$

$$1 \leq y \leq 8$$

$$0 \leq z \leq 2y + 1$$

$$1 \leq n \leq 3 \text{ and}$$

M^{n+} is a monovalent to trivalent cation, in particular:



where R^1 to R^8 are H, $C_yF_{2y+1-z}H_z$ or an aromatic radical

where $M^{n+} = Li^+, Na^+, Cs^+, K^+$ and Ag^+ are excluded.

Preference is given to fluoroalkyl phosphates of the formula





5 It has been found that the compounds according to the invention have very high electrochemical stability. The fluoroalkyl phosphates of the general formula (I) according to the invention can thus be employed, in pure form and in the form of their mixtures, as conductive salts in primary and secondary batteries, capacitors, supercapacitors and galvanic cells. It is also possible for the fluoroalkyl phosphates according to the invention to be used as conductive salt together with further salts known to the person skilled in the art.

10 The fluoroalkyl phosphates according to the invention are preferably used in pure form as conductive salt, since in this way particularly good reproducibility of the electrochemical properties can be achieved.

15 The fluoroalkyl phosphates are prepared starting from phosphoranes, which are prepared by the process described in DE 196 411 38. From 0.5 to 3 molar, preferably from 1.5 to 2.5 molar, solutions or suspensions of these phosphoranes or of the fluoroalkyl phosphates are prepared in organic aprotic solvents, preferably selected from the group consisting of the carbonates, esters, ethers, nitriles, amides, ketones, sulfonic acid esters, sulfonamides, sulfoxides, phosphoric acid esters, phosphoranes and mixtures thereof. Particularly preferred solvents are solvents or mixtures thereof which are directly suitable for use in a primary or secondary battery, a capacitor, a supercapacitor or a galvanic cell, such as, for example, dimethyl carbonate, diethyl carbonate, propylene carbonate, ethylene carbonate, ethyl methyl carbonate, methyl propyl carbonate, 1,2-dimethoxyethane, 1,2-diethoxyethane, methyl acetate, γ -butyrolactone, ethyl acetate, methyl propionate, ethyl propionate, methyl butyrate, ethyl butyrate, dimethyl sulfoxide, dioxolane, sulfolane, acetonitrile, acrylonitrile, tetrahydrofuran, 2-methyltetrahydrofuran or mixtures thereof.

25 For the reaction with fluoroalkyl phosphates, equimolar amounts or a slight excess of metal or nonmetal fluorides or chlorides, preferably

selected from the group consisting of $[\text{NR}^1\text{R}^2\text{R}^3\text{R}^4]\text{F}$, $[\text{NR}^1\text{R}^2\text{R}^3\text{R}^4]\text{Cl}$, $[\text{P}(\text{NR}^1\text{R}^2)_4]\text{F}$, $[\text{P}(\text{NR}^1\text{R}^2)_4]\text{Cl}$, $[\text{C}(\text{NR}^1\text{R}^2)_3]\text{Cl}$ and $[\text{C}(\text{NR}^1\text{R}^2)_3]\text{F}$, are added. For the reaction with phosphoranes, $\text{N}(\text{CH}_3)_4\text{F}$, $\text{N}(\text{C}_2\text{H}_5)_4\text{F}$, $[\text{P}[(\text{CH}_3)_2]_4]\text{F}$ or $\text{C}[\text{N}(\text{CH}_3)_2]_3\text{F}$ is added in equimolar amounts or in a slight excess. The mixture is stirred at temperatures between 0°C and 50°C , preferably at room temperature. It is stirred for from 0.5 hour to 48 hours, preferably for from 2 to 12 hours. In the case of the formation of a by-product, the reaction solution is subsequently cooled and the by-product separated off. In the reactions in which no by-product is formed, the reaction mixture can be further employed directly.

The resultant electrolytes are suitable for use in primary batteries, secondary batteries, capacitors, supercapacitors and galvanic cells and likewise represent a subject-matter of the present invention.

The concentration of the fluoroalkyl phosphate(s) according to the invention in these electrolytes is preferably from 0.01 to 4 mol/l, particularly preferably from 0.5 to 3 mol/l.

The invention also relates to primary batteries, secondary batteries, capacitors, supercapacitors and galvanic cells which contain at least one fluoroalkyl phosphate of the general formula (I) according to the invention and optionally further salts and/or additives. These further salts and additives are known to the person skilled in the art, for example from Doron Aurbach, *Nonaqueous Electrochemistry*, Marc Dekker Inc., New York 1999; D.Linden: *Handbook of Batteries*, Second Edition, McGraw-Hill Inc., New York 1995, and G. Mamantov and A.I. Popov, *Chemistry of Nonaqueous Solutions*, Current Progress, VCH Verlagsgemeinschaft, Weinheim 1994. They are hereby incorporated by way of reference and are thus regarded as part of the disclosure.

The fluoroalkyl phosphates according to the invention can be used with conventional electrolytes. Examples of suitable electrolytes are those with conductive salts selected from the group consisting of LiPF_6 , LiBF_4 , LiClO_4 , LiAsF_6 , LiCF_3SO_3 , $\text{LiN}(\text{CF}_3\text{SO}_2)_2$ and $\text{LiC}(\text{CF}_3\text{SO}_2)_3$, and mixtures thereof. The electrolytes may also comprise organic isocyanates (DE 199 44 603) for reducing the water content. The electrolytes can likewise comprise organic alkali metal salts (DE 199 10 968) as additive. Suitable are alkali metal borates of the general formula



in which,

m and p are 0, 1, 2, 3 or 4 where m+p=4 and

R¹ and R² are identical or different,

5 are optionally bonded directly to one another by a single or double bond,

are each, individually or together, an aromatic or aliphatic carboxylic, dicarboxylic or sulfonic acid radical, or

10 are each, individually or together, an aromatic ring from the group consisting of phenyl, naphthyl, anthracenyl or phenanthrenyl, which may be unsubstituted or mono- to tetrasubstituted by A or Hal, or

are each, individually or together, a heterocyclic aromatic ring from the group consisting of pyridyl, pyrazyl or bipyridyl, which may be unsubstituted or mono- to trisubstituted by A or Hal, or

15 are each, individually or together, an aromatic hydroxy acid from the group consisting of aromatic hydroxycarboxylic acids and aromatic hydroxysulfonic acids, which may be unsubstituted or mono- to tetrasubstituted by A or Hal,

and

20 Hal is F, Cl or Br

and

A is alkyl having 1 to 6 carbon atoms, which may be mono- to trihalogenated. Likewise suitable are alkali metal alkoxides of the general formula



in which R

is an aromatic or aliphatic carboxylic, dicarboxylic or sulfonic acid radical, or

30 is an aromatic ring from the group consisting of phenyl, naphthyl, anthracenyl or phenanthrenyl, which may be unsubstituted or mono- to tetrasubstituted by A or Hal, or

is a heterocyclic aromatic ring from the group consisting of pyridyl, pyrazyl and bipyridyl, which may be unsubstituted or mono- to trisubstituted by A or Hal, or

5 is an aromatic hydroxy acid from the group consisting of aromatic hydroxycarboxylic acids and aromatic hydroxysulfonic acids, which may be unsubstituted or mono- to tetrasubstituted by A or Hal,

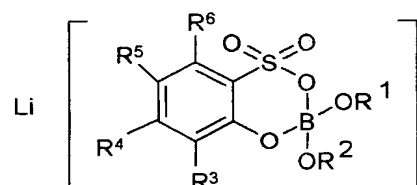
and

Hal is F, Cl or Br

and

10 A is alkyl having 1 to 6 carbon atoms, which may be mono- to trihalogenated.

Lithium complex salts of the formula



where

15 R¹ and R² are identical or different, are optionally bonded directly to one another via a single or double bond, and are each, individually or together, an aromatic ring from the group consisting of phenyl, naphthyl, anthracenyl or phenanthrenyl, which may be unsubstituted or mono- to hexasubstituted by alkyl (C₁ to C₆), alkoxy groups (C₁ to C₆) or halogen (F, Cl or Br),
20

or are each, individually or together, an aromatic heterocyclic ring from the group consisting of pyridyl, pyrazyl or pyrimidyl, which may be unsubstituted or mono- to tetrasubstituted by alkyl (C₁ to C₆), alkoxy groups (C₁ to C₆) or halogen (F, Cl or Br),

25 or are each, individually or together, an aromatic ring from the group consisting of hydroxybenzocarboxyl, hydroxynaphthalenecarboxyl, hydroxybenzosulfonyl and hydroxynaphthalenesulfonyl, which may be

unsubstituted or mono- to tetrasubstituted by alkyl (C₁ to C₆), alkoxy groups (C₁ to C₆) or halogen (F, Cl or Br),

R³ - R⁶ may each, individually or in pairs and optionally bonded directly to one another by a single or double bond, have the following meanings:

1. alkyl (C₁ to C₆), alkoxy (C₁ to C₆) or halogen (F, Cl or Br)
2. an aromatic ring from the groups consisting of

phenyl, naphthyl, anthracenyl and phenanthrenyl, which may be unsubstituted or mono- to hexasubstituted by alkyl (C₁ to C₆), alkoxy groups (C₁ to C₆) or halogen (F, Cl or Br),

pyridyl, pyrazyl and pyrimidyl, which may be unsubstituted or mono- to tetrasubstituted by alkyl (C₁ to C₆), alkoxy groups (C₁ to C₆) or halogen (F, Cl or Br),

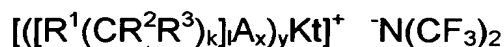
which are prepared by the following process (DE 199 32 317):

a) chlorosulfonic acid is added to 3-, 4-, 5- or 6-substituted phenol in a suitable solvent,

b) the intermediate from a) is reacted with chlorotrimethylsilane, and the reaction mixture is filtered and subjected to fractional distillation,

c) the intermediate from b) is reacted with lithium tetramethoxyborate(1-) in a suitable solvent, and the end product is isolated therefrom, may also be present in the electrolyte.

The electrolytes may likewise comprise compounds of the following formula (DE 199 41 566):



where

Kt= N, P, As, Sb, S or Se

A= N, P, P(O), O, S, S(O), SO₂, As, As(O), Sb or Sb(O)

R¹, R² and R³

are identical or different and are

H, halogen, substituted and/or unsubstituted alkyl C_nH_{2n+1} , substituted and/or unsubstituted alkenyl having 1-18 carbon atoms and one or more double bonds, substituted and/or unsubstituted alkynyl having 1-18 carbon atoms and one or more triple bonds, substituted and/or unsubstituted cycloalkyl C_mH_{2m-1} , mono- or polysubstituted and/or unsubstituted phenyl, or substituted and/or unsubstituted heteroaryl,

A may be included in R^1 , R^2 and/or R^3 in various positions,

Kt may be included in a cyclic or heterocyclic ring,

the groups bonded to Kt may be identical or different,

where

$n = 1-18$

$m = 3-7$

$k = 0 \text{ or } 1-6$

$l = 1 \text{ or } 2 \text{ in the case where } x=1 \text{ and } 1 \text{ in the case where } x=0$

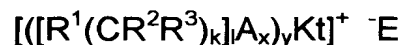
$x = 0 \text{ or } 1$

$y = 1-4$.

The process for the preparation of these compounds is characterised in that an alkali metal salt of the general formula



where D^+ is selected from the group consisting of the alkali metals, is reacted, in a polar organic solvent, with a salt of the general formula

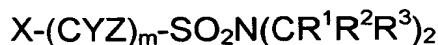


where

Kt, A, R^1 , R^2 , R^3 , k, l, x and y are as defined above, and

^-E is F^- , Cl^- , Br^- , I^- , BF_4^- , ClO_4^- , AsF_6^- , SbF_6^- or PF_6^- .

However, use can also be made of electrolytes comprising compounds of the general formula (DE 199 53 638)



where

5 X is H, F, Cl, C_nF_{2n+1} , C_nF_{2n-1} or $(SO_2)_kN(CR^1R^2R^3)_2$

Y is H, F or Cl

Z is H, F or Cl

R^1 , R^2 and R^3 are H and/or alkyl, fluoroalkyl or cycloalkyl

m is 0-9 and, if $X=H$, $m \neq 0$

10 n is 1-9

k is 0 if $m=0$ and $k=1$ if $m=1-9$,

prepared by reacting partially or perfluorinated alkylsulfonyl fluorides with dimethylamine in organic solvents, and complex salts of the general formula (DE 199 51 804)



in which:

x and y are 1, 2, 3, 4, 5 or 6

M^{x+} is a metal ion

E is a Lewis acid selected from the group consisting of

20 $BR^1R^2R^3$, $AlR^1R^2R^3$, $PR^1R^2R^3R^4R^5$, $AsR^1R^2R^3R^4R^5$ and $VR^1R^2R^3R^4R^5$,

R^1 to R^5 are identical or different, are optionally bonded directly to one another by a single or double bond, and each, individually or together, are

a halogen (F, Cl or Br),

25 an alkyl or alkoxy radical (C_1 to C_8), which may be partially or fully substituted by F, Cl or Br,

an aromatic ring, optionally bonded via oxygen, from the group consisting of phenyl, naphthyl, anthracenyl or phenanthrenyl, which may be unsubstituted or mono- to hexasubstituted by alkyl (C₁ to C₈) or F, Cl or Br,

an aromatic heterocyclic ring, optionally bonded via oxygen, from the group consisting of pyridyl, pyrazyl or pyrimidyl, which may be unsubstituted or mono- to tetrasubstituted by alkyl (C₁ to C₈) or F, Cl or Br, and

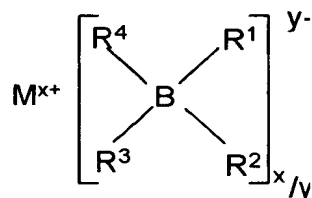
Z is OR⁶, NR⁶R⁷, CR⁶R⁷R⁸, OSO₂R⁶, N(SO₂R⁶)(SO₂R⁷), C(SO₂R⁶)(SO₂R⁷)(SO₂R⁸) or OCOR⁶, where

R⁶ to R⁸ are identical or different, are optionally bonded directly to one another by a single or double bond and are each, individually or together,

hydrogen or as defined for R¹ to R⁵,

prepared by reacting a corresponding boron or phosphorus Lewis acid/solvent adduct with a lithium or tetraalkylammonium imide, methanide or triflate, can be used.

Borate salts (DE 199 59 722) of the general formula



in which:

M is a metal ion or tetraalkylammonium ion,

x and y are 1, 2, 3, 4, 5 or 6,

R¹ to R⁴ are identical or different and are alkoxy or carboxyl radicals (C₁-C₈), which are optionally bonded directly to one another by a single or double bond,

may also be present. These borate salts are prepared by reacting lithium tetraalkoxyborate or a 1:1 mixture of lithium alkoxide with a borate with a suitable hydroxyl or carboxyl compound in a ratio of 2:1 or 4:1 in an aprotic solvent.

5 These electrolytes can be employed in electrochemical cells, with negative electrodes made from common lithium intercalation and insertion compounds, but also with negative-electrode materials consisting of lithium mixed oxide particles coated with one or more metal oxides (DE 199 22 522) by suspending the particles in an organic solvent, adding a solution of a hydrolysable metal compound and a hydrolysis solution to the suspension, and then filtering off, drying and optionally calcining the coated particles. They may also consist of lithium mixed oxide particles coated with one or more polymers (DE 199 46 066) obtained by a process in which the particles are suspended in a solvent, and the coated particles are subsequently filtered off, dried and optionally calcined.

The fluoroalkyl phosphates according to the invention have the advantage of being electrochemically stable. This property enables conductive salts comprising the compounds according to the invention to be employed in batteries, capacitors, supercapacitors and galvanic cells.

Examples

The invention is explained below with reference to examples. These examples serve merely to explain the invention and do not restrict the general inventive thinking.

Example 1

Preparation of $N(C_2H_5)_4[PF_3(C_2F_5)_3]$ via $Li[PF_3(C_2F_5)_3]$

Equimolar amounts of $N(C_2H_5)_4X$ ($X = F$ or Cl) are added to a 1.5 to 2.5 molar solution of $Li[PF_3(C_2F_5)_3]$ in acetonitrile. The solution is stirred at room temperature for a number of hours, during which a slight sediment of LiX forms. The reaction mixture is then held at from $-30^\circ C$ to $-10^\circ C$ for a further 2 hours, and the resultant precipitate is filtered off at from $-30^\circ C$ to $-10^\circ C$ under reduced pressure. The solvent is removed by distillation. After subsequent drying at $100^\circ C$ under reduced pressure, the product can be obtained in the form of colourless granules.

^{19}F -NMR spectroscopy (CD_3CN ; standard: CCl_3F):

-43.6 dm (1F)

-79.7 m (3F)

-81.3 m (6F)

-87.0 d (2F)

-115.3 m (4F)

-115.7 m (2F)

Example 2

Preparation of $\text{N}(\text{CH}_3)_4[\text{PF}_3(\text{C}_2\text{F}_5)_3]$ via $\text{PF}_2(\text{C}_2\text{F}_5)_3$

An equimolar amount of $\text{N}(\text{CH}_3)_4\text{F}$ is added at to 10 g of $\text{PF}_2(\text{C}_2\text{F}_5)_3$ (prepared in accordance with DE 198 466 36) in acetonitrile. The mixture is stirred for a number of hours until the initial; phase boundary has disappeared. The solution is used directly with $\text{N}(\text{CH}_3)_4[\text{PF}_3(\text{C}_2\text{F}_5)_3]$ as conductive salt.

^{19}F -NMR spectroscopy (CD_3CN ; standard: CCl_3F):

-45.0 d (1F)

-81.0 s (9F)

-83 d (2F)

-112 m (2F)

-121 m (2F)

-124 m (2F)

Example 3

Preparation of $\text{N}(\text{CH}_3)_4[\text{PF}_3(\text{C}_4\text{F}_9)_3]$ via $\text{PF}_2(\text{C}_4\text{F}_9)_3$

The preparation is carried out analogously to Example 2 starting from $\text{PF}_2(\text{C}_4\text{F}_9)_3$. The cation source employed is $\text{N}(\text{CH}_3)_4\text{F}$.

Example 4

Preparation of $\text{P}[\text{N}(\text{CH}_3)_2]_4[\text{PF}_3(\text{C}_2\text{F}_5)_3]$ and $\text{P}[\text{N}(\text{CH}_3)_2]_4[\text{PF}_3(\text{C}_4\text{F}_9)_3]$

The preparation is carried out analogously to Example 2. The cation source employed is $\text{P}[\text{N}(\text{CH}_3)_2]_4\text{F}$.

Example 5

Preparation of $P[N(CH_3)_2]_4[PF_3(C_4F_9)_3]$ and $P[N(CH_3)_2]_4[PF_3(C_2F_5)_3]$

The preparation is carried out analogously to Example 1. The cation source employed is $P[N(CH_3)_2]_4Cl$.

5

Example 6

Preparation of $C[N(CH_3)_2]_3[PF_3(C_2F_5)_3]$ and $C[N(CH_3)_2]_3[PF_3(C_4F_9)_3]$

The preparation is carried out analogously to Example 2. The cation source employed is $C[N(CH_3)_2]_3F$.

10

Example 7

Electrochemical stability of the electrolytes

In a measurement cell with stainless steel, platinum or gold working electrode, lithium counterelectrode and lithium reference electrode, in each case 5 cyclic voltammograms were recorded one after the other. To this end, the potential was firstly increased starting from the rest potential at a rate of 10 mV/s or 20 mV/s to 6 V against Li/Li^+ , and then moved back to the rest potential. In order to be able to utilise the highest possible electrochemical window, a 1:1 mixture of EC and DMC was used as solvent.

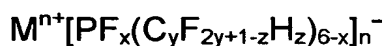
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All electrolytes here exhibit a positive-electrode stability of greater than 5 V. Figure 1 shows this in a representative manner for the electrolyte comprising $[PF_3(C_2F_5)_3]^-$.

PATENT CLAIMS

1. Fluoroalkyl phosphates of the general formula (I)



5 (I)

in which

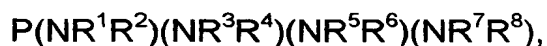
$$1 \leq x \leq 6$$

$$1 \leq y \leq 8$$

$$0 \leq z \leq 2y + 1$$

10 $1 \leq n \leq 3$ and

M^{n+} is a monovalent to trivalent cation, in particular:



where R^1 to R^8 are H, $C_yF_{2y+1-z}H_z$ or an aromatic radical

where $M^{n+} = Li^+, Na^+, Cs^+, K^+$ and Ag^+ are excluded.

2. Process for the preparation of fluoroalkyl phosphates according to Claim 1,
characterised in that phosphoranes are reacted with a fluoride or fluoroalkyl
20 phosphates are reacted with a fluoride or chloride in organic aprotic sol-
vents.

3. Process for the preparation of fluoroalkyl phosphates according to Claim 2, characterised in that fluoroalkyl phosphates are reacted with $[\text{NR}^1\text{R}^2\text{R}^3\text{R}^4]\text{X}$, $[\text{P}(\text{NR}^1\text{R}^2)_4]\text{X}$ or $[\text{C}(\text{NR}^1\text{R}^2)_3]\text{X}$, where $\text{X} = \text{F}$ or Cl and R^{1-4} are as defined above.
- 5 4. Process for the preparation of fluoroalkyl phosphates according to Claim 2, characterised in that phosphoranes are reacted with $\text{N}(\text{CH}_3)_4\text{F}$, $\text{N}(\text{C}_2\text{H}_5)_4\text{F}$, $[\text{P}[\text{N}(\text{CH}_3)_2]_4]\text{F}$ or $[\text{C}[\text{N}(\text{CH}_3)_2]_3]\text{F}$.
- 10 5. Process for the preparation of fluoroalkyl phosphates according to one of Claims 2 to 4, characterised in that the fluorinated alkylphosphoranes are reacted in a solvent or solvent mixture which is directly suitable for use in a primary or secondary battery, a capacitor, a supercapacitor or a galvanic cell.
- 15 6. Process for the preparation of the fluoroalkyl phosphates according to Claims 2 to 5, characterised in that organic aprotic solvents are selected from the group consisting of the carbonates, esters, ethers, nitriles, amides, ketones, sulfonic acid esters, sulfonamides, sulfoxides, phosphoric acid esters, phosphoranes and mixtures thereof.
- 20 7. Process according to Claims 2 to 6, characterised in that the solvents employed are dimethyl carbonate, diethyl carbonate, propylene carbonate, ethylene carbonate, ethyl methyl carbonate, methyl propyl carbonate, 1,2-dimethoxyethane, 1,2-diethoxyethane, methyl acetate, γ -butyrolactone, ethyl acetate, methyl propionate, ethyl propionate, methyl butyrate, ethyl butyrate, dimethyl sulfoxide, dioxolane, sulfolane, acetonitrile, acrylonitrile, tetrahydrofuran, 2-methyltetrahydrofuran or mixtures thereof.
- 25 8. Fluoroalkyl phosphates obtainable by the process according to one of Claims 2 to 7.

9. Use of at least one fluoroalkyl phosphate according to one of Claims 1 or 8 as conductive salt in primary batteries, secondary batteries, capacitors, supercapacitors and/or galvanic cells, optionally also in combination with further salts.
- 5 10. Electrolytes for primary batteries, secondary batteries, capacitors, supercapacitors and/or galvanic cells comprising at least one fluoroalkyl phosphate according to one of Claims 1 or 8.
11. Electrolytes according to Claim 10, characterised in that the concentration of the fluoroalkyl phosphate(s) in the electrolyte is from 0.01 to 4 mol/l, preferably from 0.5 to 3 mol/l.
- 10

A B S T R A C T

The present invention relates to fluoroalkyl phosphates, to a process for the preparation, and to their use as conductive salts in batteries, capacitors,
5 supercapacitors and galvanic cells.

Figure 1

